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Issued May 29, 1914.

PORTO RICO AGRICULTURAL EXPERIMENT STATION,
D. W. MAY, Special Agent in Charge,
Mayaguez, P. R.

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Bulletin No. 13.

PORTO RICAN BEEKEEPING.

BY

E. F. PHILLIPS, PH. D.,

*In Charge, Bee Culture Investigations, Bureau of Entomology,
U. S. Department of Agriculture.*



UNDER THE SUPERVISION OF
OFFICE OF EXPERIMENT STATIONS,
U. S. DEPARTMENT OF AGRICULTURE.

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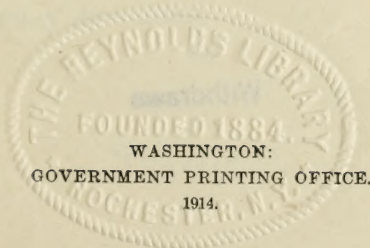
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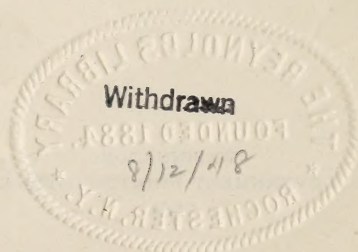
PORTO RICO AGRICULTURAL EXPERIMENT STATION.

[Under the supervision of A. C. TRUE, Director of the Office of Experiment Stations, United States
Department of Agriculture.]

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(2)



LETTER OF TRANSMITTAL.

PORTO RICO AGRICULTURAL EXPERIMENT STATION,
Mayaguez, P. R., January 9, 1914.

SIR: I have the honor to transmit herewith a manuscript on Porto Rican Beekeeping, by E. F. Phillips, Ph. D., in charge of the bee-culture investigations of the United States Department of Agriculture, Bureau of Entomology.

This station began work on beekeeping under Mr. W. V. Tower, former entomologist, in 1908, and has continued its investigations ever since. In 1913, at the invitation of the station and the insular board of agriculture, Dr. Phillips visited the island and made a careful survey of the situation. The accompanying manuscript gives the results of his observations, together with recommendations whereby the industry could be further extended and developed.

On account of the rapid development of this industry, which has grown from almost nothing to an export trade of \$100,000 in five years, and in view of the unusual opportunities for its further development, I recommend that this manuscript be published as Bulletin 15 of this station and that it be issued both in English and in Spanish editions.

Respectfully,

D. W. MAY,
Special Agent in Charge.

Dr. A. C. TRUE,
*Director Office of Experiment Stations,
U. S. Department of Agriculture, Washington, D. C.*

Recommended for publication.

A. C. TRUE, *Director.*

Publication authorized.

D. F. HOUSTON,
Secretary of Agriculture.

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PORTO RICAN BEEKEEPING.

INTRODUCTION.

Beekeeping in Porto Rico is increasing in extent and importance with great rapidity. While honey production on the island can never equal in importance the production of sugar, fruits, or coffee, there is, however, an opportunity for the further development of this industry which should not be lost, and recent development gives promise of a bright future. The reports of large honey crops obtained on the island received by the Bureau of Entomology of the United States Department of Agriculture and the recent progress in the development of the beekeeping industry made it seem desirable that a trip of investigation be taken to the island, and this trip the author made during the months of May and June, 1913. Since the results of this three weeks' visit may be of value to beekeepers on the island or on the mainland, a brief résumé is here given of what was observed personally and learned from others.

The author feels it a pleasure to thank for their many kindnesses the beekeepers whose apiaries were visited. Special thanks are due the insular board of commissioners of agriculture for their courtesy, especially in providing transportation, and to Mr. W. V. Tower, entomologist and secretary of the board, who accompanied the author over most of the island. Since the present beekeeping industry of Porto Rico is largely the result of Mr. Tower's efforts, no better opportunity could be found for studying beekeeping on the island than to go with him on such a trip and to have the aid of his knowledge of the subject and of his acquaintance with the beekeepers.

Porto Rico is at the eastern end of the Greater Antilles, the capital, San Juan, being 1,380 miles from New York and 1,565 miles from New Orleans. In length it is about equal to Long Island and is about 40 miles wide at the widest point, the island proper having an area of 3,516 square miles. The wonderful productiveness of the island is shown by the fact that it supports over a million people and maintains a balance of trade in its favor.

Prior to the American occupation (Oct. 18, 1898) beekeeping had not developed in Porto Rico to the extent that it had on some of the other islands of the West Indies. Several factors doubtless contributed to this condition, but an important one was the lack of roads suitable for the transportation of colonies, supplies, and the products

of the hive. It would seem probable that bees were introduced early in the history of the Spanish colony, although Tower¹ believes that Mr. Filippi, of Mayaguez, who introduced them from Switzerland to the hacienda Juanita, in the Las Marias district (date not recorded), was the first. These bees were destroyed by the San Ciriaco hurricane of 1899. The following quotation from Busck² is of interest in this connection:

One striking feature in the insect fauna is the abundance of honeybees and no bee-hives; at least I neither saw nor heard of any, and they must be a rarity. Still the honey harvest is quite important, although the figures given in the last Estadística General del Comercio Exterior, of Puerto Rico (\$517,746), of the exportation thereof surely must be wrong, unless they possibly include molasses. Very large colonies of a dark variety of *Apis mellifica* were abundant in hollow trees and especially in caves, sometimes also in outhouses. These are annually smoked out and furnish large quantities of honey."

Busck collected specimens of the honeybee at Bayamon, Mayaguez, Utuado, Aguadilla, Fajardo, and Arroyo. These are deposited in the United States National Museum, together with one collected February 22, 1900, by C. W. Richmond from El Yunque (800 feet elevation).

The exports of honey³ in 1897 (immediately preceding American rule) amounted to 1,350 liters, valued at 405 pesos, which was all shipped to the United States. The local consumption of honey is small even yet, so that the amount exported gives a rather accurate idea of the honey produced or obtained from wild colonies. The limited local consumption is probably due to the use of honey chiefly as a medicine by the people of Porto Rico. Gifford⁴ records finding charred tabanuco trees on the Luquillo National Forest, "probably purposely fired by some native to secure honey or for some other purpose."

It was recognized, however, that there was opportunity for the development of the industry. The veteran naturalist, Dr. Augustin Stahl,⁵ of Bayamon, wrote in 1899 as follows:

Apiculture is unknown in this country, where the bee finds material at hand for the preparation of honey and wax. If men of understanding should be sent to teach our people this industry, the gain in the future therefrom would be considerable.

Following the American occupation the building of good roads was begun and is still being continued, so that the inaccessible areas are being rapidly reduced. Better facilities for transportation permitted a few men to take up beekeeping by modern methods independently, but it did not become general.

¹ Tower, W. V. Ann. Rpt. Porto Rico Hort. Soc., 1 (1912), pp. 64-68. Porto Rico Prog., 2 (1911), No. I, pp. 69-79 (in English and Spanish).

² Busck, A. U. S. Dept. Agr., Div. Ent. Bul. 22, n. ser., p. 90. (1900.)

³ Carroll, H. K. Report on the Island of Porto Rico. [U. S.] Treasury Dept. Doc. 2118, pp. 153, 155.

⁴ Gifford, John C. U. S. Dept. Agr., Bur. Forestry Bul. 54, p. 28.

⁵ In Report on the Island of Porto Rico. [U. S.] Treasury Dept. Doc. 2118, p. 222.

In July, 1908, the Porto Rico Agricultural Experiment Station at Mayaguez imported five nuclei of Italian bees from an American breeder, and Mr. W. V. Tower,¹ station entomologist, took up the problem of developing the industry of beekeeping on the island. Interest in the work increased rapidly, and interested persons came from all parts of the island, particularly from the coffee districts, for the purpose of learning the care of bees and honey production.

Mayaguez is on the extreme western end of the island, and it is at once noticed that the industry is developed chiefly with Mayaguez as a center, there being still relatively few beekeepers in the eastern half of the island. In 1911 a circular on beekeeping by W. V. Tower² was published in English and Spanish, and it has been necessary to reprint this several times to meet the continued demand. To Mr. Tower must go the credit of virtually creating the beekeeping industry of Porto Rico as it exists to-day. This is one of the important pieces of work originating with the Agricultural Experiment Station at Mayaguez. (Pl. I, fig. 1.) After Mr. Tower left the station Dr. C. W. Hooker³ was appointed entomologist. He took an active interest in beekeeping and was engaged in a study of the honey plants previous to his untimely death in February, 1913. Since there were at first few places where bees could be obtained by those desirous of beginning beekeeping, nuclei were raised at the station apiary and sold. Since bees may be increased in Porto Rico with amazing rapidity, the offspring of the original five nuclei probably now comprise colonies numbering into the thousands.

OUTLINE OF TRIPS.

To give some idea of the opportunities for observing the possibilities for beekeeping which the author was fortunate enough to have, the following brief outline of the principal trips by days is appended:

1. From San Juan to Ponce by the Spanish military road, with a side trip to Cidra.
2. From Ponce to Jayuya and return.
3. From Ponce out on the road toward La Carmelita and return.
4. From Ponce, through Adjuntas, Utuado, Arecibo, and Aguadilla, to Lares.
5. From Lares about 15 kilometers on new road to Adjuntas and return; from Lares through Aguadilla to Mayaguez.
6. From Mayaguez through Ponce and Guayama, thence across the island to Rio Piedras.

¹ Porto Rico Sta. Rpt. 1908, p. 27. (See also Porto Rico Sta. Rpts. 1909, 1910, 1911.)

² Porto Rico Sta. Circ. 13.

³ Porto Rico Sta. Rpt. 1912, p. 38.

7. From Rio Piedras around the east end of the island, through Fajardo, Naguabo, Humacao, to Guayama, thence across the island.

8. From San Juan to Arecibo and return with side trips to Ciales and up the Morovis River.

Two days were spent in the Mayaguez district and the remainder of the time in the region about San Juan. The trips enumerated were made by automobile except the one on the Carmelita road. It will be seen that these trips combine to make a circuit of the island and to cross it four times on three different roads. The time occupied was from May 30 to June 18.

PRESENT EXTENT OF THE INDUSTRY.

As previously stated, beekeeping is carried on chiefly on the west end of the island, with a few beekeepers elsewhere. Without a careful survey it would be unwise to estimate the number of persons engaged in the business and such an estimate would be too small almost before it is made. Most of the present beekeepers are Porto Ricans, only a few Americans being interested so far. To one interested in the future development of the industry one of the most important considerations is the type of beekeeper encountered. In the United States, especially in the East, there are thousands of beekeepers owning but a few colonies, constituting the class commonly called amateur beekeepers. Where such beekeeping is carried on the professional beekeeper has less opportunity for the development of a good business and, as a result, beekeeping becomes a plaything in many cases. There are a few beekeepers in Porto Rico who have only a few colonies, but, fortunately for the future of the industry, the apiaries are usually large and almost universally it is planned to increase them in size and number. This promises well for the future.

The corporation plan of beekeeping has not taken hold in Porto Rico as it has in Hawaii¹ and in most cases the beekeeper maintains but one apiary. They are, however, almost all planning to establish out-apiaries. When it is recalled that most of the beekeepers have but two or three years experience, it is a matter of wonder that they have done as well as they have. The beekeepers of Porto Rico have before them the serious problem of long distance for shipping their supplies and their crops, just as do the beekeepers of Hawaii, and it is not unlikely that in the near future it will be found advantageous to form companies.

The following records of shipments of honey and beeswax from Porto Rico were compiled by the Bureau of Statistics of the United States Department of Agriculture, with some additions kindly furnished by the collector of customs of the port of San Juan, Mr. D. E. Richardson.

¹ Phillips, E. F. U. S. Dept. Agr., Bur. Ent. Bul. 75, pt. 5, p. 44.

Exports of honey from Porto Rico.

| Year ending June 30— | Value of shipments from Porto Rico to the United States. | Value of exports from Porto Rico to foreign countries. | Total value. |
|----------------------|--|--|--------------|
| 1901..... | \$46 | | \$46 |
| 1902..... | 598 | \$30 | 628 |
| 1903..... | | | |
| 1904..... | 266 | | 266 |
| 1905..... | 302 | | 302 |
| 1906..... | 516 | | 516 |
| 1907..... | 2,897 | | 2,897 |
| 1908..... | 5,381 | | 5,381 |
| 1909..... | 9,469 | | 9,469 |
| 1910..... | 1 9,170 | 1 225 | 1 9,395 |
| 1911..... | 17,904 | 2,810 | 20,714 |
| 1912..... | 42,251 | 3,350 | 45,601 |
| 1913..... | 1 59,721 | 1 9,520 | 1 69,241 |
| 1914..... | | | 2 68,392 |

¹ Furnished by the collector of customs, San Juan.² To January 31, 1914.

The importation of honey from foreign countries is small, as shown by the accompanying table. The importation of honey is now prohibited (see p. 21).

Imports of honey into Porto Rico from foreign countries.

| Year ending June 30— | Gallons. | Value. |
|----------------------|----------|--------|
| 1909..... | 155 | \$70 |
| 1910..... | 20 | 15 |
| 1911..... | 53 | 22 |
| 1912..... | 40 | 15 |

The reported shipments of beeswax are relatively high, due possibly to the marketing of wax taken from colonies in the woods. No imports from foreign countries are reported.

Exports of beeswax from Porto Rico.

| Year ending June 30— | Shipments from Porto Rico to the United States. | | Exports from Porto Rico to foreign countries. | |
|-------------------------|---|--------|---|--------|
| | Pounds. | Value. | Pounds. | Value. |
| 1901..... | 1,612 | \$397 | | |
| 1902..... | 795 | 227 | | |
| 1903..... | | | | |
| 1904..... | 5,434 | 778 | | |
| 1905..... | 1,081 | 230 | | |
| 1906..... | 6,848 | 1,851 | | |
| 1907..... | 5,045 | 1,245 | | |
| 1908..... | 8,337 | 2,160 | | |
| 1909..... | | | | |
| 1910..... | | | 114 | \$30 |
| 1911..... | 15,459 | 4,078 | 1,438 | 453 |
| 1912..... | 18,262 | 5,324 | | |
| 1913..... | 23,120 | 6,425 | | |
| 1914 ¹ | 18,140 | 5,620 | | |

¹ To January 31, 1914.

It is generally believed by the beekeepers of the island that a good location can support from 200 to 300 colonies and in some cases they are planning to make them considerably larger. While in more northern locations it is considered good practice to keep large apiaries two or three miles apart, this is not so necessary in Porto Rico. The mountainous character of the island greatly influences the flight of the bees and not infrequently bees in apiaries a half mile apart will scarcely enter each other's field. It is reported that Columbus, who discovered the island in 1493, likened it to a silk handkerchief dropped from one's hand, and this well describes the character of the surface.

Several beekeepers kindly furnished records of their crops as an indication of the possibilities for honey production on the island. Tower gives the record of two hives at Mayaguez as follows:¹

During a period of nine months from one of the colonies there were extracted 470 pounds of honey, while the other produced 337 pounds. The only period when both colonies were not gathering was during September, and during this month the small colony gathered sufficient honey so that it did not have to use any of its surplus. Beginning the latter part of February and through March, April, and May the bees worked on the general bloom, and it was not uncommon for them to gather from one to two pounds of honey per day. July and August were good honey months; during these months one of the hives gathered 203 pounds of honey.

One beekeeper produced almost 250 barrels (of 600 pounds each) from 550 colonies in 1912. Another apiary cleared almost \$2,000, including the increase valued at a reasonable price, after about two years with an original investment valued at \$600. In both of these cases the colonies were being increased in number, thereby reducing the honey crop. A record of 531 pounds from a single hive and another of 305½ pounds were obtained from scale readings in one year. Hooker² reports that one colony gathered 357 pounds and another 539 pounds at Mayaguez. These are in continuation of the above-mentioned records by Tower. During the latter part of the year in which these records were made Hooker reports conditions as unsatisfactory on account of heavy rain. One beekeeper proudly exhibited a colony which produced over a barrel of honey in 1912, while another, not to be outdone, claimed that one colony had produced for him a barrel and a half in 1912. It is probably a fair estimate to say that the good beekeeper in Porto Rico in an average locality takes 300 pounds of extracted honey per colony. An estimate of this magnitude will perhaps be accepted with a reservation of doubt by the beekeeper of the North. Whether crops of this size will continue when the island is more thoroughly stocked with bees can not be determined, but even with a greatly reduced average beekeeping will still be profitable.

As will be discussed later, the trees used as coffee shade are particularly good honey plants, and as a result the districts where

¹ Porto Rico Sta. Rpt. 1911, p. 34.

² Loc. cit.

coffee is grown are considered the best bee regions. The fact that these honey sources are of economic importance in other ways insures their protection and the future of beekeeping. Coffee is grown on the mountains more abundantly on the west end of the island. There are, however, other honey sources which make beekeeping profitable almost everywhere except in the arid portions of the south coast. There are many locations which are obviously good where practically no bees are to be found as yet and there are still others which should be tried out. Some of the plants which are probably good honey plants are sufficiently abundant in certain localities to make extensive beekeeping profitable if the plants come up to expectations. The honey resources of the island are developed to so small an extent that a mere guess as to the future opportunities would not be valuable.

SOURCES OF HONEY.

This subject has been treated by Tower in his various papers to which reference has been made and by Navarrete,¹ and Dr. C. W. Hooker was engaged on this problem at the time of his death. The comparative value and availability of the various plants as sources of nectar has been determined only for the most important ones where bees are now kept on the island, and one of the problems most necessary to the beekeepers of the island is a careful study of this subject. Obviously in a short trip it is impossible to form independently an adequate opinion of the merits of honey plants, particularly by one who is seeing many of them for the first time. The following data were obtained from various sources on the island and are intended merely as a suggestion of the nectar resources. Anyone interested in the plants of Porto Rico will find Cook and Collins's² "Economic Plants of Porto Rico" of value. Frequent reference is made to this work.

Guamá (*Inga laurina*). This plant is regarded by many of the beekeepers as the best honey plant, especially in the lower coffee regions. It blooms two, three, or four times a year, depending on the rainfall. It ranks second only to guava (*I. vera*) as a shade tree for coffee, and is therefore abundant. One beekeeper reports that when guamá is in bloom it would be impossible to overstock a coffee district. The guamá blossoms first at the lower levels and gradually advances up the mountains. This was well seen in going from Ponce to the north, and also near Mayaguez. The honey from this plant is light amber in color, as nearly as could be determined by consulting the beekeepers.

¹ Navarrete, Agustín. Porto Rico Prog., 1 (1911), Nos. 25, p. 25; 26, p. 21.

² U. S. Nat. Mus., Contrib. Nat. Herbarium, 8 (1903), pt. 2.

Guava,¹ or guaba (*Inga vera*). This species is the chief shade for coffee, and by many beekeepers, especially in the higher altitudes, is given as the chief honey source. It blooms almost all the year, and, while the honey flows are usually not so heavy as from guamá, it produces an abundance. The honey is reported as light amber in color.

Royal palm, *Palma real* (*Roystonea borinquena*).² This native palm is one of the most characteristic features of the landscape of Porto Rico. It is present in all parts of the island, except the higher altitudes, and when in bloom, if accessible to bees, the number of bees at work on it and the noise they make might lead the visiting beekeeper to think that a swarm had issued. This species, while not so important to the beekeeper as those named previously, is an important honey source and in some localities is doubtless sufficiently abundant to support large apiaries. The author saw some comb honey at Rio Piedras which, according to his informants, was from royal palm. This honey was a light amber color and of excellent flavor. The trees bloom at any time of the year. (Pl. I, fig. 2.)

Coconut palm (*Cocos nucifera*). This species is abundant along the coast and is usually not classed as one of the best honey plants. One apiary³ of 84 colonies was visited at Mayaguez, where this was an important source. Like the royal palm, this species continues to bloom throughout the year without regular periods. Because of the economic importance of this palm, it is extensively cultivated, and the beekeeper is therefore assured of any help which may come from this plant.

Jobo (*Spondias lutea*). Common³ used extensively for shade, and limbs used for fence posts usually take root. Tower⁴ reports that bees do not gather from this plant after about 10 o'clock in the morning. The same authority also reports that bees work on ciruela del pais (*S. purpurea*).

Moca, cabbage tree (*Andira jamaicensis*). Sometimes used for coffee shade, but is inferior for this purpose on account of its slow growth. An excellent honey plant, blooming for a long period. Found in all parts of the island.

Palo blanco, Varital (*Drypetes glauca*). Euphorbiaceous shrub distributed generally in forests and in pastures. Bees work on it freely even when guamá is in bloom.

¹ This plant should not be confused with *Psidium guajava*, from the fruit of which the well-known guava jelly is made and which the author listed as a honey plant from Hawaii (Phillips, loc. cit., p. 49). *Psidium guajava*, which is more correctly known in Porto Rico as *guayava* or *guayaba*, is also abundant on the island and doubtless contributes to the honey flow.

² Distinct from *R. regia*, Cuban royal palm (Cook and Collins, loc. cit., p. 231).

³ This apiary was interesting also in that it is located in an old abandoned sugar mill or central of the old type, the bees flying out through windows. The necessary flight through the rather dark room seemed not to confuse the bees, and the apiary looked prosperous.

⁴ Porto Rico Sta. Circ. 13, p. 28.

Coffee, Café (*Coffea arabica*). Coffee is grown extensively in the interior of the island. It blooms several times during the year, but the flowers soon drop. It is of little value to the beekeeper compared with the trees used to shade it.¹ Furnishes pollen.

Guara (*Cupania americana*). Used as coffee shade and has a long blossoming period.

Rose apple, Pomarosa (*Jambosa jambos*). Abundant in thickets and forests.

Mango (*Mangifera indica*). Long blooming period. Bees are also fond of the dropped overripe fruit, according to Mr. W. E. Hess, plant propagator of the Porto Rico Experiment Station. Bees do not injure the whole fruit.

Aguacate, alligator pear (*Persea gratissima*).

Lantana, Cariaquillo (*Lantana* spp.). This plant, which was listed by the author as a weed honey plant in Hawaii, is found in all parts of Porto Rico, but is of minor importance to the beekeeper, nor does it constitute a pest on cattle ranges as in Hawaii.

Botoncillo (*Borreria ocimoides*). A shrub which produces some nectar throughout the year, sufficient in some localities to keep the colonies in good condition. Abundant throughout the island.

Cadillo (probably *Corchorus hirsutus*). Has floral and extra-floral nectaries.

Banana (*Musa* spp.). Nectar in male flowers. Pollen. (See Pl. I, fig. 1.)

Oranges, lemon, lime, etc (*Citrus* spp.). Bees are sometimes used in citrus groves to assist in pollination. Citrus trees are found growing wild over the island and are also cultivated extensively.

Century plant (*Agave* spp.). Not uncommon. Of doubtful value.

Cojóbana, Cojoba, Saman (*Pithecolobium* spp.). Several species, all of which are honey plants.

Algaroba or algarobo. This name is applied to *Hymenæa courbaril* and also to *Pithecolobium saman* (saman). The algaroba of southern Europe is *Ceratonia siliqua*. The two trees of Porto Rico known by this name are reported as honey plants. The name algaroba is also applied to the *Prosopis juliflora* of Hawaii, of the genus to which the mesquite of the southwestern United States belongs.² *Prosopis juliflora* (not the Texas mesquite), which is such an important economic plant and an excellent honey plant in Hawaii, has been introduced into Porto Rico and is growing well at hacienda Santa Rita, where the trees were seen by the author. The seeds of these plants were obtained in Peru by Guanica Central and the plants are reported as having bloomed in eight months from planting (reported by D. L. Van Dine). This introduction is worthy of more

¹ For a discussion of the shade trees used for coffee and their value to the coffee tree cf. Cook, O. F. U. S. Dept. Agr., Div. Bot. Bul. 25.

² See Phillips, loc. cit., pp. 47-48.

than ordinary notice, for if this plant thrives, as it promises, it will be a great honey source, occupying territory not now available to the beekeeper, and the pods will also be of value for fodder and the tree will furnish firewood. It will grow on salty arid lands otherwise unsuitable for agriculture. It is further reported that trees planted at Rio Piedras on the north side of the island on red-clay soil and with different climatic conditions did not thrive. In Hawaii the honey from algaroba is "water white," and this will be of marked advantage to the Porto Rican beekeepers, since most of their honey is darker. This leguminous species is reported by Grisebach as abundant in dry situations in Jamaica, where the name "cashaw" is applied to it.

Miss Perkins in her paper on the Leguminosæ of the island¹ lists 67 genera and 141 species. Most of these plants probably contribute their share to the beekeeper and many of them are sufficiently abundant to be of marked value.

Cook and Collins and other authorities report the following plants which possibly contribute to the honey resources of the island. Many of them are known as honey plants elsewhere.

Black mangrove (*Avicennia nitida*). Common in tidal swamps. The swampy nature of much of the coast of the island offers abundant room for mangroves. The salt marshes are frequently traversed by inlets connecting lagoons and the mangroves bound these on all sides. The author can not state from personal knowledge whether these mangrove swamps will prove to be good locations for apiaries, but if the black mangrove is sufficiently abundant it will pay well to try out these situations. The black mangrove of Florida is not surpassed as an excessive producer of nectar even by the guamá.

Cassia spp. Valuable chiefly for pollen, except partridge pea (*C. chamæcrista*) of Florida, which is not recorded by Cook and Collins or Perkins for Porto Rico. Species of the closely related genus *Chamæcrista* are also reported.

Cotton (*Gossypium* spp.). Not important.

Eucalyptus spp. Introduced by the Porto Rico Agricultural Experiment Station. Honey from some species is not of agreeable flavor.

Manchineel, Manzanillo (*Hippomane mancinella*). Important in Florida. Reported, but apparently not common.

Sweet clover (*Melilotus* spp.). An attempted introduction at the Porto Rico Agricultural Experiment Station was reported as unsuccessful.

Tobacco (*Nicotiana tabacum*). Reported as an important honey plant in Connecticut. Cultivated extensively in Porto Rico, but frequently under cloth where it would be inaccessible to bees.

¹ Perkins, Janet. U. S. Nat. Mus., Contrib. Nat. Herbarium, 10 (1907), pt. 4.

Erythrina spp. *E. monosperma* (Hawaiian, *wiliwili*) is a honey plant in Hawaii. *E. micropteryx* is used for coffee shade.

Sida spp. The Ilima of Hawaii belongs to this genus.

Emajugua or majugua (*Paritium tiliaceum* or *Hibiscus tiliaceus*). This plant, which was discussed by the author as the source of extra floral plant honeydew in Hawaii (as hau),¹ is present in abundance in Porto Rico. The fiber of this plant is used in making a durable rope. No reports of bees working on the leaves of this plant were received. The extra floral nectaries are present on the leaves and the outside of the calyx leaves. Ants were observed working on these in Porto Rico by the author.

Campeachy wood, logwood (*Hæmatoxylon campechianum*). Important in Jamaica. Honey nearly water-white and of excellent flavor. Gifford reports not having found it in Porto Rico, but according to Mr. J. R. Johnston it occurs near Ponce, Cabo Rajo, Mayaguez, and Isabela.

Beans, habas, or habichuela. Various spp.

Flame tree, *Flamboyan* (*Poinciana regia*). Planted widely along roads, in plazas, and elsewhere.

Sugar cane, *caña de azucar* (*Saccharum officinarum*). Bees are reported as working on cut stalks.

Blackheart or water smartweed (*Polygonum acre*). Valuable in wet lands of Illinois and southward.

Opuntia spp. Valuable in Texas. Possibly of little value in Porto Rico on account of location.

Lippia spp. *L. nodiflora* (Cidrón) carpet grass. Recommended for lawns.

Bidens spp.

Various species of acacia.

Corozo palm (*Acrocomia media*).

Fortunately for the growers of sugar cane, the sugar-cane leaf-hopper (*Perkinsiella saccharicida*) which produces so much honeydew in Hawaii² is absent from Porto Rico. This source of honeydew is therefore not available to the beekeeper. The West Indian leaf-hopper of the cane (*Delphax saccharivora*) is present, but it is not reported as of interest to the beekeeper as it is never abundant except on young cane. Doubtless there are many insects on the island which exude honeydew, but the nearly constant supply of nectar makes this of no importance to the honey producer. Bees are not kept near cane fields in Porto Rico as they are in Hawaii.

EQUIPMENT AND METHODS OF MANIPULATION.

In the apiaries visited a rather marked similarity was observed in the arrangement of hives, apparatus, and management. This was

¹ Phillips, loc. cit., pp. 53, 54.

² Phillips, loc. cit., pp. 49-53.

explained when the apiary of the Mayaguez station was visited (Pl. II, fig. 1), since many of the beekeepers have patterned after the apiary in detail. Extracted honey is produced almost exclusively. The apparatus for this purpose was in all cases new and in fine condition. Power extractors are not in use and probably with the high price of gasoline and the cheap labor available these would not pay.

Almost all the bees in the better apiaries are Italians, and many of them are the offspring of the original five nuclei imported in 1908 by the Mayaguez station. Considerable attention is being paid to the keeping of good stock, and several of the beekeepers are importing good Italian queens. The long period of brood rearing (in most districts throughout the entire year) makes requeening desirable more frequently than in the North. A few beekeepers are experimenting with Cyprian and Carniolan bees. Since Cyprians in the hands of beekeepers in the United States have shown more bad qualities than good ones, the Porto Rican beekeepers may well profit by the experience of their fellow workers in the United States, where this race has been practically abandoned.

The beekeepers of the island are to be congratulated in that the 10-frame Langstroth hive is standard with them. Most of the hives and other supplies used are manufactured in the United States, but some of the beekeepers are making their own hives, and in several cases the home-made hives were not cut with the accuracy to be desired. Some arrangement should be made by the beekeepers to get their supplies at a lower rate. At the time of the author's visit they were paying an advance over the catalogue prices, which is seemingly not justified by freight rates to Porto Rico from New York City.

One or two extracting supers are placed above the brood chamber and are separated from it by a queen excluder. Extracting is done frequently, as is necessary with so little storage space. In many cases the quality of the honey might be improved by providing more supers and leaving the honey on the hives to thicken for a longer time. The beekeepers of Porto Rico are practically all new at the business and are still in feverish excitement to get their honey off and marketed, although less haste at this point would doubtless profit them. The use of the queen excluder is in general to be commended, as honey is certainly more desirable when not stored in old brood combs. However, an old brood comb toughened by the accumulation of "cocoons" is much less apt to break during extracting, and in certain systems of manipulation an interchange of combs between the brood chamber and supers is desirable. With a prolific queen, one 10-frame hive body is scarcely sufficient for the brood chamber.

Gloves and heavy wire cloth veils are commonly used, which again shows the influence of the Mayaguez station. Since in many apiaries



FIG. 1.—THE APIARY OF THE AGRICULTURAL EXPERIMENT STATION AT MAYAGUEZ FROM WHICH BEES HAVE BEEN SENT TO ALL PARTS OF THE ISLAND.



FIG. 2.—ROYAL PALMS, ALSO SHOWING CHARACTER OF THE COUNTRY IN THE CENTER OF THE ISLAND.



FIG. 1.—APIARY AT JAYUYA, SHOWING CHARACTER OF COUNTRY. THE MOUNTAINS ARE COVERED WITH COFFEE SHADED CHIEFLY BY GUAMÁ AND GUAVA.



FIG. 2.—PACK USED IN CARRYING HONEY IN 100 POUND CANS DOWN THE MOUNTAINS, JAYUYA.

the bees are crosser than need be, this is not an unwelcome protection. More gentle treatment in opening and manipulating colonies would in many cases make such unwieldy apparatus unnecessary. Gloves especially are a nuisance. Hive stands are necessary to keep the bottom boards from rotting in the moist climate of Porto Rico and also to keep out ants and especially white ants (comejens).

The customary package for shipping is a 50-gallon barrel. The barrels of honey are usually hauled down the mountains on bull carts. Since most of the shipping ports are as yet not provided with docks, the honey must be taken out on lighters to the boat. This is probably an adequate explanation of the use of barrels, but the beekeepers claim that the buyers so prefer the honey. One beekeeper reported having tried 5-gallon tin cans, but that they were damaged in transportation. There seems to be no adequate excuse for this as the beekeepers of Hawaii use them successfully with much more difficult transportation, especially in their inter-island shipping. The 5-gallon tin can is the usual package for extracted honey in the United States and when two cans are cased together it is a desirable package for shipping and handling. Residents of Porto Rico are certainly familiar enough with the 5-gallon square can as it is one of the commonest sights on the island. Oils are shipped in such tins and, after emptying, the cans form a convenient unit of measure for the coffee picker, a vessel for carrying water or any other commodity on the head, and are even used to side or roof the huts of the peons.

An undesirable arrangement of the apiary was noticed several times which should and in most cases easily could be remedied. The apiary and extracting house should be so arranged that the heavy supers of honey are carried downhill to the house and placed available for uncapping without the necessity of lifting. The honey should then run from the extractor into a tank (galvanized iron), where it should be allowed to settle for a time. The honey should finally be drawn off from the bottom of the tank to barrels or cans placed on a still lower level. Many beekeepers were running their honey from the extractor directly into barrels, but the quality of the honey would be improved by settling as here recommended, since it is impossible to take out all the wax particles and other materials simply by allowing the honey to pass through cheese cloth or wire cloth. In a mountainous country it should be easy to arrange the apiary so that heavy lifting is avoided and, even with labor as cheap as it is, this arrangement will be profitable. A few of the beekeepers have realized the desirability of such a system and, in one case in particular near Lares, a rather elaborate scheme is being worked out so that the honey will reach the road below without unnecessary lifting.

As will be discussed later, one of the difficulties of the Porto Rican beekeeper is thin honey. This may in part be obviated by ripening the honey by keeping it in tanks exposed to the heat of the sun (see p. 19). This is another argument in favor of the use of the storage tank.

In one particular many of the beekeepers of the island are probably at a disadvantage. Many of the apiaries are located on or near the tops of mountains so that the returning bees must carry the loads of honey uphill. That this is not the best practice has seemingly not been considered by many of the bee men. It is at least logical to suppose that the beekeepers would reap larger crops per colony if the bees could fly up without a load and glide back to the hives heavily laden.*

Most of the apiaries are so arranged that the morning sun strikes the hives, thus getting the bees to the fields early. This is an important consideration and seems especially so in mountainous regions. It is quite common to have the hives covered by a shed or roof so that they are protected from the tropical sun at midday. Bananas are often used for shade and a thatched roof of royal palm leaves (*yaguas*), grass, sugar cane, or coconut leaves is common. These coverings are of special value in enabling the beekeeper to work with his bees when it is raining, as is the case almost every afternoon in some sections.

Not a single efficient wax extracting apparatus was seen by the author, and the beekeepers are certainly losing by neglecting the wax. Large solar wax extractors or good capping melters should be used to render the cappings, and presses much heavier than those now used should be used to remove wax from old combs. In a large apiary the wax which can be obtained by adequate apparatus is of considerable value, and it will pay the Porto Rican beekeeper to buy or more probably to make large presses like those used by extensive beekeepers in the West.

DIFFICULTIES ENCOUNTERED.

In addition to the relatively high cost of transportation by bull carts of apiary supplies from the coast and of honey and wax to the coast, there are some other difficulties with which the beekeeper of Porto Rico must cope.

The most of the honeys are amber in color, comparing somewhat unfavorably with the lighter honey of the North for fancy table use. With the development of the industry and more information concerning the various sources it is not unlikely that some white honey may be produced. With the more intense development of the industry it may become profitable to separate the honeys so that the light honey may be sold separately and at a higher price. At present it seems probable that it is not profitable to attempt any

such separation. This results in practically all Porto Rican honeys which come to the United States markets being blends of rather dark honeys. It must be remembered, however, that the market value of a "water-white" honey is usually not sufficiently greater than that of amber honey to make it profitable to spend much labor in separating them.

In regions where the relative humidity is high the percentage of water in honeys is greater than in dry regions.¹ This is probably due to the fact that in moist regions evaporation takes place more slowly and even if the honey does become thick it may take up moisture from the moist atmosphere and become thin again. In many localities in Porto Rico the rainfall is excessive, resulting in a high relative humidity. A considerable number of the samples of honey examined on the island were thin, although this was by no means universal. It was further reported by a beekeeper at Mayaguez that honey sometimes ferments in the comb, causing bubbles to form and the honey to leak from the comb through the capping, even while still in the hive. No sour taste was noticed in any of the honeys so that it seems probable that the fermentation does not proceed far enough to injure the product for market.

To insure a uniformly ripe product it will probably pay to experiment with some method of artificial ripening. If honey is stored in tanks out in the hot tropical sun, evaporation will take place rapidly, and, while the moisture in the atmosphere will to some extent be taken up by the exposed honey, probably in a few days of such storage the honey will become thick. The shape and character of such a tank must be determined by trials. Of course the tank must be screened to keep out bees, and it may be desirable to have it of some dark color so that more heat will be absorbed. Probably a flat tank offering a relatively large surface for evaporation will be preferable.

The beekeeper must, however, not place too much confidence in artificial ripening, but must leave the honey in the hives until it is ripened as much as may be by the bees. There is reason to believe that some of the beekeepers are extracting too soon. This is quite frequently done by beginners everywhere, for it is somewhat difficult to resist the temptation to get the product on the market immediately. It is far more important that Porto Rican honeys become known for their quality than for their quantity. The loss of a single barrel by fermentation will mean more than the slight gain which would result in selling a little too much water in the honey.

Porto Rican beekeepers are handicapped by a lack of practical books and journals in Spanish. Many of them are now able to read those published in the United States, at least to some extent, and as the younger generations come from the schools where English is

¹ Browne, C. A. U. S. Dept. Agr., Bur. Chem. Bul. 110, p. 51.

taught this difficulty will probably diminish. However, it would be a great boon to the industry if good books on beekeeping in Spanish were available.

The limited knowledge of the honey flora probably does not appear as a great drawback to the present beekeepers with their abundant crops. However, if information were available doubtless regions now considered unsuitable could be opened up. Furthermore, more reliable information would probably enable the beekeepers to prepare for the special harvests by getting their colonies in better condition. One of the problems which should be worked out is a detailed study of the plants which produce nectar, with special reference to their distribution, relative merit, and abundance. It would be of considerable value if the individual beekeeper would take careful notes of the plants on which the bees work.

In the moist climate of Porto Rico, hives and bottoms decay rather quickly and experiments in the use of creosote paints and oils should be tried to prevent this. The use of cement for hives and parts, which has been suggested, would virtually prohibit the transportation of colonies and should be tried only as a last resort.

USE OF BEES FOR POLLINATION.

Tower¹ calls attention to the value of bees to the coffee grower in cross-pollinating coffee, especially in seasons when there is considerable rain at blossoming time. Coffee is wind-pollinated in dry weather, but in damp weather little fruit is set if few insect visitors are at hand. One of the largest citrus fruit growers on the island is planning to increase the number of colonies among his trees, solely for the benefit derived in cross-pollinating.

The author has estimated² that bees in the North are of more value to the fruit grower in their good offices of cross-pollinating than they are to the beekeeper in the honey with which they supply him. This is coming more and more to be recognized.

It is reported that bees suck the juice of overripe mangoes, and it may not be amiss to repeat here that bees do not puncture sound fruit, but suck the juice only from overripe fruit which is punctured by some other insect or in some other manner. They are assuredly not the enemies of the fruit grower in this respect. The building up of the beekeeping industry is therefore as much to the interest of the fruit grower as to the persons who engage in the business of honey production.

DISEASES OF BEES.

As far as known, American foul brood or European foul brood do not occur in Porto Rico. American foul brood is reported as uncom-

¹ Porto Rico Sta. Circ. 13, p. 5.

² Phillips, E. F. U. S. Dept. Agr., Bur. Ent. Bul. 75, pt. 6, p. 71.

monly abundant in certain other islands of the West Indies and it is a matter of surprise that Porto Rico has escaped. The fact that beekeeping was virtually undeveloped under Spanish rule probably explains this piece of good fortune.

The Insular Legislative Assembly enacted a law which contains the following section:

Be it enacted by the Legislative Assembly of Porto Rico:

Sec. 5. That no bee comb, larvæ, pupæ, or bees shall be brought into Porto Rico from any other place: *Provided*, That queen bees, accompanied by not more than 30 worker bees and without bee comb containing eggs, larvæ, pupæ, or bees, may be introduced therein in mailing cages or small boxes. (Act No. 60, approved and effective Sept. 3, 1910.)

By the act of March 9, 1911 (No. 45), creating the board of commissioners of agriculture, the inspection at the ports of entry is vested in the board, and this duty is assigned to the entomologist of the board. Mr. W. V. Tower was appointed to this position and still holds it. By the authority of the act of September 3, 1910, several nuclei have been refused entrance.

The wisdom of the action of the legislature at a period when the industry was beginning its recent development is beyond question, and it may be considered as most fortunate that this matter was urged just when it was.

There still remained a possible source of danger, however. A study of the distribution of the brood diseases in the United States has led the author to believe that disease enters a new locality by means of honey from infected colonies more frequently than through the shipping of diseased colonies. In view of this belief, the author drafted the following recommendation which was presented to the chairman of the scientific committee of the board of commissioners of agriculture just before sailing:

(1) That the regulations designed to prevent the introduction of the brood diseases of bees be amended to prohibit the importation of honey except such as may come from an apiary or apiaries certified to be free of disease by an official inspector of apiaries.

On July 14, 1913, the board passed a regulation covering this recommendation, in accordance with the authority vested in the board in the creating act of March 9, 1911.

While but a small amount of honey was being shipped to the island (see p. 9), the risk incident to such shipments was unwarranted and the regulation will to all intents and purposes prohibit the importation of all honey.

POSSIBILITY OF WAX PRODUCTION.

While the system of excellent roads being built by the government of Porto Rico offers as good facilities for transportation as could be

asked, there are and will doubtless always remain hundreds of localities well suited for beekeeping where transportation of honey is almost impossible. One method of carrying the honey over mountain trails is shown in Plate II, figure 2. Such conditions, coupled with the abundantly available supply of nectar, call for a trial of still another phase of beekeeping which has hitherto been neglected on the island.

In the author's discussion of Hawaiian beekeeping¹ there was suggested a plan for increasing the wax output with a possible decrease in honeydew honey production. This plan, with certain changes rendering it better suited to local conditions, has been put into operation and from reports received there is no cause for regret at the suggestion. For localities of a more inaccessible nature a still further step may prove desirable. Before discussing this suggestion it should be recalled (1) that neither American foul brood nor European foul brood is known in Porto Rico, and (2) that there is an almost constant flow of nectar. These points are vital to the plan here brought forward.

If a colony of bees is located in a large hive with a capacity of 12 to 18 Langstroth frames, or, perhaps better, in two 10-frame hive bodies or on "Jumbo" ($17\frac{5}{8}$ by $11\frac{1}{4}$ inches) frames, there will be plenty of room for brood rearing. If now over this is placed a box, of size to be determined by the resources of the locality, without frames, separated from the brood chamber by a queen excluding zinc, the bees will, with possibly some encouragement, go into this box to store their surplus. When the box is filled the bees may be removed by a bee-escape board and all the combs may be cut out, except possibly one to serve as a "ladder" for the bees in beginning work again and as a reserve in case of inclement weather. The honey may then be separated from the comb by pressure or by means of a solar wax extractor and then so placed as to be available to the bees again. It might be desirable to dilute it somewhat before feeding back. If no other bees are in range, the feeding can be done in the open, otherwise a large feeder of perhaps 5 gallons capacity under the brood chamber might be devised. The wax obtained can be cleaned of honey and put up in 100-pound cakes for market. Two such cakes can be carried out on horseback in one pack. If the honey flow were always heavy, there might be some difficulty in getting the bees to take up all the honey that is obtained, but during the winter months and in rainy weather, of which there is usually considerable, they would handle large quantities. Since there will be after the initial crop more than the normal supply of food, it is not unlikely that very large apiaries can be kept in each suitable location.

¹ Loc. cit., p. 54-56.

The author is fully aware that it is usually believed that 15 to 20 pounds of honey are consumed in producing 1 pound of wax, and it may therefore appear that the plan suggested is not economical and therefore not practical. However, it is more than doubtful whether any such amount of honey is so consumed. When conditions are right for wax secretion the cost in honey is usually small and the honey obtained may be fed over and over again until consumed. Where packing of honey and delivery to New York or other market exceeds two or three cents a pound, the author would have faith enough in this plan to try it. Of course if the honey is obtained faster than it can be fed back, over and above what the bees will take up, it might be possible to carry some down by horses to a road suitable for bull carts. Probably in the present undeveloped condition of the island it will pay the prospective beekeeper to choose a location suitable for honey production, but when the easily accessible places are taken up, it will pay to consider this plan. Possibly an apiary manipulated for wax as here suggested may be a rather unpleasant place to work, for the feeding of the honey may cause the bees to be cross and to rob. This may be overcome by adequate protection, and if robbing is suggested, the hives should be tight and entrances made as small as the temperature will permit.

FUTURE OUTLOOK AND RECOMMENDATIONS.

As has been stated directly and by inference several times previously, the future outlook for beekeeping in Porto Rico is bright. With the further utilization of the nectar resources which are now so largely wasted there will probably come a reduction in the average crops. If this occurs it will tend to eliminate any beekeepers who are not thoroughly informed as to the best methods of practice, but there will still be room for the beekeeper with necessary equipment in information and experience. The development of those parts of the island where bees are not now kept commercially is a crying need. While Porto Rico is growing commercially in a surprising manner it is important that the opportunity for the development of this industry be embraced and it is worthy of attention by those interested in the upbuilding of the island.

As stated in the introduction, honey production will never rank as one of the chief agricultural industries. However, an industry which promises to bring \$100,000 to the island in the fiscal year ending June 30, 1914, after less than five years' growth, may be expected far to exceed this amount when the available locations are taken up.

The authorities interested in the development of this industry should profit by the experience in beekeeping elsewhere in determining the class of beekeepers which should be encouraged. When bees are

kept in small apiaries averaging some half dozen colonies the output is small and the beekeepers, not being sufficiently interested in a financial way, usually sell their product for too low a price. As a rule, too, the product is inferior. Under such circumstances the professional beekeeper has little opportunity for the development of a good business. Such a condition prevails in much of the eastern United States, but this is rapidly changing because the brood diseases are eliminating the careless disinterested beekeepers and the professional beekeepers are profiting by it. In the West the industry is usually in the hands of extensive beekeepers. This is the more necessary on account of the distance from the supply manufacturers and from market. Porto Rico is so situated that beekeeping should be in the hands of professional beekeepers or even of corporations. To give the greatest commercial benefit to the island, the shipments should be large and a market can then be developed for Porto Rican honey.

Porto Rico has certain special problems in beekeeping which in all probability will be worked out in time by the beekeepers themselves. The ripening of the honey, the saving or even the special production of wax, and detailed information concerning the honey flora may be mentioned as three problems which appear now to be the most pressing. To wait, however, until the beekeepers work out these things will be to retard the industry in its possible development. Recognizing this condition, the author recommends that a good beekeeper from the States be obtained to work out these problems and others which will present themselves, as well as to conduct an experimental and demonstration apiary where prospective beekeepers may come to learn the business. That this recommendation has been favorably considered is gratifying.

The future of the beekeeping industry in Porto Rico is full of promise. The problems are now two in number: (1) The development of the industry as rapidly as is consistent with the experience of the beekeepers, and (2) the keeping out of the brood diseases.

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